A.D. 1867, 31st MAY. N° 1621.

Apparatus for Producing Cold.

LETTERS PATENT to Rees Reece, of Llandilo, in the County of Carmarthen, Chemist, for the Invention of "AN IMPROVED MODE OF AND APPARATUS FOR PRODUCING COLD."

Sealed the 26th November 1867, and dated the 31st May 1867.

PROVISIONAL SPECIFICATION left by the said Rees Reece at the Office of the Commissioners of Patents, with his Petition, on the 31st May 1867.

I, REES REECE, of Llandilo, in the County of Carmarthen, Chemist, do hereby declare the nature of the said Invention for "AN IMPROVED MODE OF AND APPARATUS FOR PRODUCING COLD," to be as follows:—

The said Invention consists chiefly in the peculiar construction and arrangement of apparatus for effecting the continuous distillation and rectification of dilute solution of ammonia upon what is known as the separative principle, and in the combination with the said apparatus of a condenser and refrigerator. The ammoniacal gas is reduced by its own pressure to a liquid condition in the said condenser, from which it passes into the refrigerator, and having a very low temperature quickly abstracts the heat from any fluid passed through the latter.

A boiler is connected with an analyser which consists of a series of plates arranged in the usual manner inside a strong iron vessel. The analyser is connected with a rectifier which is provided with a series of hollow discs or drums arranged one above the other with a space between them. The said discs or drums are connected in such a manner that a passage is formed from end to

end of the same for a continuous stream of cold water. The rectifier may also be formed of a series of vertically arranged tubes surrounded by cold water, through which tubes the ammoniacal fluid passes to the condenser; the latter may be constructed of tubes arranged like those of the analyser, or may be simply a cylindrical or other suitably shaped iron vessel strong enough to resist the internal pressure of the gas, the said vessel being immersed in cold water. The condensed ammonia passes from the condenser to a refrigerator, which may be of any convenient form and construction. The fluid cooled in the refrigerator parts with the greater portion of its heat to the condensed ammonia, which is thus again vaporized, and in this form passes into an absorbing vessel; the said vessel is kept cold by water, and serves to maintain the required vacuum in the refrigerator. The ammoniacal solution passes from the absorber into a heating vessel, from which it is returned into the analyser. In some cases the analyser may be dispensed with and the boiler connected immediately with the rectifier. The boiler may be of iron or other suitable metal, and may be constructed in any manner that will render it strong enough to withstand the pressure. Where an analyser is used the said boiler is connected to the same by pipes provided with stop-cocks or other convenient means of regulation. The said analyser is provided with a series of plates arranged as in other similar vessels employed for separative distillation. A heating apparatus is provided to heat the solution of ammonia previous to its introduction into the analyser, and is connected to the top of the said analyser by a suitable pipe or tube, and by another pipe to the boiler. The said analyser is also provided with a tube to convey the spent liquor to the boiler. The rectifier is placed above the analyser, and is connected thereto by a short tube or other convenient means; the said rectifier is provided with a series of hollow metal discs or cylinders arranged one over the other with a space between them. Each of the said discs or cylinders is connected to the next in the series by a short tube, so that a passage is formed from end to end of the series through which a continuous stream of cold water passes from a cistern or other vessel placed over the rectifier and escapes from a discharge pipe at the lower end of the series. The upper end of the rectifier is connected by a pipe or tube to a strong iron condenser which is enclosed in a cistern of cold water provided with suitable inlet and outlet pipes for the same. The said condenser is connected at its lower end to a vessel which receives the condensed ammonia. Stop-cocks or valves are provided to close the communication between the condenser and receiving vessel and to regulate the supply of ammonia to the latter. The receiver is connected with the refrigerating apparatus, which by preference consists of a gas-tight chest

or box containing a series of tubes closely fitted to each other and communicating at their ends in such a manner as to form a passage through them from end to end of the series. The fluids to be refrigerated pass through these tubes, whose exterior surface is surrounded by the liquid ammonia which flows into the gas-tight chest from the receiving vessel of the condenser. Any suitable blowing apparatus may be employed to force the fluids through the tubes. The liquid ammonia in the refrigerator rapidly abstracts the heat from the fluids passing through the tubes, and is again converted into gas. The chest or box is connected by a pipe to an absorbing vessel containing a coil of pipes, over which a stream of water is kept flowing. The ammoniacal gas generated in the refrigerator passes therefrom into the said vessel, and is dissolved in the water in the same. A pipe is provided to convey this ammoniacal solution into the heating apparatus. A relief valve or cock is provided between the receiver and refrigerator or other convenient portion of the apparatus to allow the air to escape, and a similar valve may be placed between the refrigerator and absorber to regulate the flow of the gas from the former into the said absorber. The rectifier may be formed of a series of vertical tubes placed in a cistern containing water at the proper temperature; or a stream of water may be caused to flow over the said tubes. The lower end of the first tube in the series is connected to the analyser, and each tube in the series is connected with the next tube in such a manner that a passage is formed from end to end of the series of tubes, the last of which is connected to the condenser. A chamber is formed at the lower end of the tubes, and division plates are placed in the said chamber to prevent the ammoniacal fluid passing direct through the chambers instead of through the tubes. The liquid condensed in the tubes falls into the said chamber, and flows therefrom through small apertures into the analyser. The condenser may also be constructed of a series of vertical tubes arranged in the same manner as those in the rectifier. The tubes both in the rectifier and condenser must be well fitted and brazed or soldered into the chambers, and the latter must be tied together by rods or bolts passing through the tubes and secured by nuts at the ends of the same. The rectifier and condenser and other parts of the apparatus must be carefully made and of sufficient strength to resist the pressure to which they are subjected. In a small apparatus it may be desirable to dispense with the analyser and to connect the rectifier directly with the boiler; in this case the ammoniacal solution would be introduced directly into the boiler instead of into the analyser.

Reece's Improved Apparatus for Producing Cold.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Rees Reece in the Great Seal Patent Office on the 30th November 1867.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, Rees Reece, of Llandilo, in the County of Carmarthen, Chemist, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Thirty-first day of May, in the year of our Lord One thousand eight hundred and sixty-seven, in the thirtieth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Rees Reece, Her special licence that I, the said Rees Reece, my executors, administrators, and assigns, or such others as I, the said Rees Reece, my executors, administrators, and assigns, should at any time agree with, and no others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "An Improved Mode of and Apparatus for Producing Cold," upon the condition (amongst others) that I, the said Rees Reece, my executors or administrators, by an instrument in writing under my, or their, or one of their hands and seals, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that I, the said Rees Reece, do hereby declare the nature of my said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement, reference being had to the accompanying Drawings forming a part of this Specification :—

The said Invention consists chiefly in the peculiar construction and arrangement of apparatus for effecting the continuous distillation and rectification of dilute solution of ammonia upon what is known as the separative principle, and in the combination with the said apparatus of a condenser and refrigerator. The ammoniacal gas is reduced by its own pressure to a liquid condition in the said condenser, from which it passes into the refrigerator, and having a very low temperature quickly abstracts the heat from any fluid passed through the latter.

A boiler is connected with an analyzer, which consists of a series of plates

arranged in the usual manner inside a strong iron vessel. The analyzer is connected with a rectifier, which is provided with a series of vertically arranged tubes, surrounded by cold water, through which tubes the ammoniacal fluid passes to the condenser; or a rectifier may be provided with a series of vessels arranged one above the other, with a space between them. The said vessels are connected in such a manner that a passage is formed from end to end of the same for a continuous stream of cold water. The condenser may be constructed of tubes arranged like those of the rectifier, or may be simply a cylindrical or other suitably shaped iron vessel strong enough to resist the internal pressure of the gas, the said vessel being immersed in cold water. The condensed ammonia passes from the condenser to a refrigerator, which may be of any convenient form and construction. The fluid cooled in the refrigerator parts with the greater portion of its heat to the condensed ammonia, which is thus again vaporized, and in this form passes into an absorbing vessel, which is kept cold by water, and which serves to maintain the required vacuum in the refrigerator. The ammoniacal solution passes from the absorber into a heating vessel, from which it is returned into the analyzer. In some cases the analyzer may be dispensed with, and the boiler connected immediately with the rectifier.

Description of the Drawings.

Figure 1 is a side elevation showing the general arrangement of the parts of my improved apparatus.

The following Figures are drawn to an enlarged scale:—

Figures 2 and 3 are a transverse and longitudinal section of the analyzer shown in Figure 1.

Figure 4 is a longitudinal section of the rectifier shown in Figure 1.

Figure 5 is an end view of the said rectifier.

Figures 6 and 7 are a plan and section illustrating a modification of the same.

Figures 8 and 9 are a plan and longitudinal section of the refrigerator shown in Figure 1.

Figure 10 is a transverse section on the line x, x, of the absorbing vessel shown in Figure 1.

Figures 11 and 12 are a longitudinal section and end view of the heating vessel shown in Figure 1.

Like letters indicate corresponding parts in each of the Figures.

The boiler A may be of iron or other suitable metal, and may be constructed in any manner that will render it strong enough to withstand the required

pressure. Where the analyzer B is used the said boiler is connected to the same by pipes *a* provided with stop-cocks *b*, or other convenient means of regulation. The said analyzer is provided with a series of cups *c* or with plates arranged as in other analyzing vessels employed for separative distillation. A heating apparatus C is provided to heat the solution of ammonia previous to its introduction into the analyzer B, and is connected to the top of the said analyzer by a suitable pipe or tube *d*, and by another pipe *e* to the boiler A. The said analyzer is also provided with a tube *f* to convey the spent liquor to the boiler. The rectifier D is placed above the analyzer B, and is connected thereto by a short tube *g* or by other convenient means. The said rectifier is provided with a series of vertical tubes *h* placed in a cistern containing water at the proper temperature or provided with means for causing a stream of water to flow over the said tubes. The lower end of the first tube h^1 in the series is connected to the analyzer B, and each tube in the said series is connected with the next tube in such a manner that a passage is formed from end to end of the series of tubes, the last tube h^2 of which is connected to the condenser. A chamber *i* is formed at the upper end, and another chamber i^1 at the lower end of the tubes *h*, and division plates *j* are placed in the said chambers to prevent the fluid passing direct through the chambers instead of through the tubes *h*. The liquid condensed in the tubes *h* falls into the chamber i^1, and flows therefrom through small apertures *k* into the analyzer B.

A rectifier constructed as shown in Figures 6 and 7 may be employed instead of that above described. The vessels *l* or hollow metal discs or cylinders are arranged one over the other with a space between them. Each of the said vessels is connected to the next in the series by a short tube l^1, so that a passage is formed from end to end of the series of vessels *l*, through which a continuous stream of cold water passes from a cistern or other vessel placed over the rectifier, and escapes from a discharge pipe l^2 at the lower end of the said series. I prefer, however, to use the rectifier shown in Figures 1, 4, and 5. The upper end of the said rectifier is connected by a pipe or tube *m* to the condenser F, over which a stream of cold water flows from a cistern or other vessel. The said condenser is connected at its lower end to a vessel G, which receives the condensed ammonia. Stop-cocks or valves *n* are provided to close the communication between the condenser F and receiving vessel G, and to regulate the supply of ammonia to the latter. The condenser F is preferably constructed of a series of vertical tubes *o*, arranged in the same manner as those in the rectifier, Figures 4 and 5. The tubes both in the rectifier and condenser must be well fitted and brazed or soldered into the sockets o^1 of the chambers at the ends of the said tubes; and these chambers

must be tied together by rods or bolts p passing through the tubes and secured by nuts p^1 at the ends of the same. The rectifier and condenser and other parts of the apparatus must be carefully made, and of sufficient strength to work safely under the pressure to which they are to be subjected. The receiver G is connected with the refrigerating apparatus H, which by preference consists of a gas-tight chest or box q containing a series of tubes r closely and compactly arranged, and communicating with each other at their ends in such a manner as to form a passage from end to end of the series of the said tubes. The fluids to be refrigerated pass through the tubes r, whose exterior surface is surrounded by the liquid ammonia, which flows into the gas-tight chest q from the receiving vessel G of the condenser. Any suitable blowing or pumping apparatus may be employed to force the fluids through the tubes r. The liquid ammonia in the refrigerator rapidly abstracts heat from the fluids passing through the tubes r, and is again converted into gas; the chest or box q is connected by a pipe s to an absorbing vessel I, containing a coil or other arrangement of pipes t, over which a stream of water is kept flowing. The ammoniacal gas generated in the refrigerator H passes therefrom into the vessel I, and is dissolved in the water in the same; at the same time a stream of cold water passes through the inside of the pipes t to abstract the heat generated by the solution of ammonia in water. A pipe u is provided to convey this ammoniacal solution into the heating apparatus C, through which it is forced into the analyzer B by means of the pump J. A relief valve or cock v is provided between the receiver G and refrigerator H, or at any other convenient portion of the apparatus to allow the air to escape, and a valve w may be placed between the refrigerator and absorber to regulate the flow of the gas from the former into the said absorber. In a small apparatus it may be desirable to dispense with the analyzer and to connect the rectifier directly with the boiler; in this case the ammoniacal solution would be introduced directly into the boiler instead of into the analyzer.

The boiler A is charged with distilled water containing from five to ten per cent. of ammonia, and steam is got up. The cocks b leading from the boiler to the analyzer B are opened, also the cocks v, v^1, to allow the confined air to escape; when the air is all driven out all the cocks on the apparatus are closed with the exception of those leading from the boiler to the analyzer. In driving the air from the apparatus it is advisable to send it through washing apparatus to dissolve any ammonia escaping with it; the apparatus is known to be free from air when the fluid passing into the washer is completely dissolved in it. When the pressure in the boiler is equal to that

of eight atmospheres a solution of ammonia is pumped into the top of the analyzer B, and falling from plate to plate comes in contact with the ascending steam and becomes exhausted of its ammonia; the liquid then flows into the boiler A, and thence through the cock e^1 passes into the heater C and there heats to the boiling point the ammoniacal liquor flowing through the pipes *y*, Figure 11, and is itself cooled down to the ordinary temperature. The spent liquor flowing from the boiler A must be regulated to maintain a constant level of water in the same; the mixture of ammonia and steam passes into the rectifier D, which is kept cool by a current of cold water passing over it. The steam being condensed flows back into the analyzer B, while the rectified ammonia passes onward into the condenser F, in which it is liquified by its own pressure. To facilitate this liquifaction the said condenser is also kept as cold as possible by a current of cold water passing over it. The liquified ammonia collects in the bottom of the condenser F and passes into the receiver G, thence to the refrigerator H until that vessel is about three-fourths full; the cock w^1 on the absorber I is now opened to allow the water in the receiver G^1 to ascend into it, when a vacuum is formed by the solution of the ammonia in the water. The cock *w* between the refrigerator H and absorber I is also opened, and the ammonia regaining its gaseous condition passes into the said absorber and is dissolved in the water flowing over the pipes. The two cocks *w*, w^1, may be regulated so that the water and ammoniacal gas is admitted in suitable proportions, which proportions are indicated by a vacuum gauge on the absorber. The temperature of the absorber I must be kept down by allowing a current of water to flow through the interior of the pipes *t*, over which the ammoniacal solution passes; the ammoniacal liquor thus obtained collects at the bottom of the vessel I, and thence is pumped into the analyzer B in a continuous manner. The spent water of the boiler A may be used in the absorber I to dissolve the ammonia; the ammonia as it passes into the absorber I from the refrigerator H reduces the temperature in the latter to a very low point, and a solution of chloride of calcium is passed through the tubes *r*, wherein it parts with its heat to the ammonia, the temperature of the said chloride being reduced to twenty or thirty degrees or more below zero centigrade; the liquid thus cooled may be used to freeze water to refrigerate brewers' wort, ale, wines, and for other refrigerating purposes. Any other liquid of a non-congealable character may be passed through the tubes; but a solution of chloride of calcium is preferable, owing to its cheapness and the low temperature to which it may be reduced without congealing; air may also be cooled by passing through the tubes.

Having thus fully described my said Invention, and shown how the same may be conveniently and advantageously carried into practice, I claim,—

First, the method of obtaining nearly anhydrous liquid ammonia by means of the analyzer B, the rectifier D, and condenser F, combined and arranged substantially in the manner set forth.

Second, the arrangement of the said rectifier and condenser with or without the analyzer in combination with the refrigerator, absorber, heater, and boiler, substantially as and for the purposes set forth.

In witness whereof, I, the said Rees Reece, have hereunto set my hand and seal, this Twenty-ninth day of November, in the year of our Lord One thousand eight hundred and sixty-seven.

REES REECE. (L.S.)

Witness,

THOS. N. PALMER,

Clerk to Messrs. Haseltine, Lake, & Co.,

8, Southampton Buildings, W.C.

LONDON:

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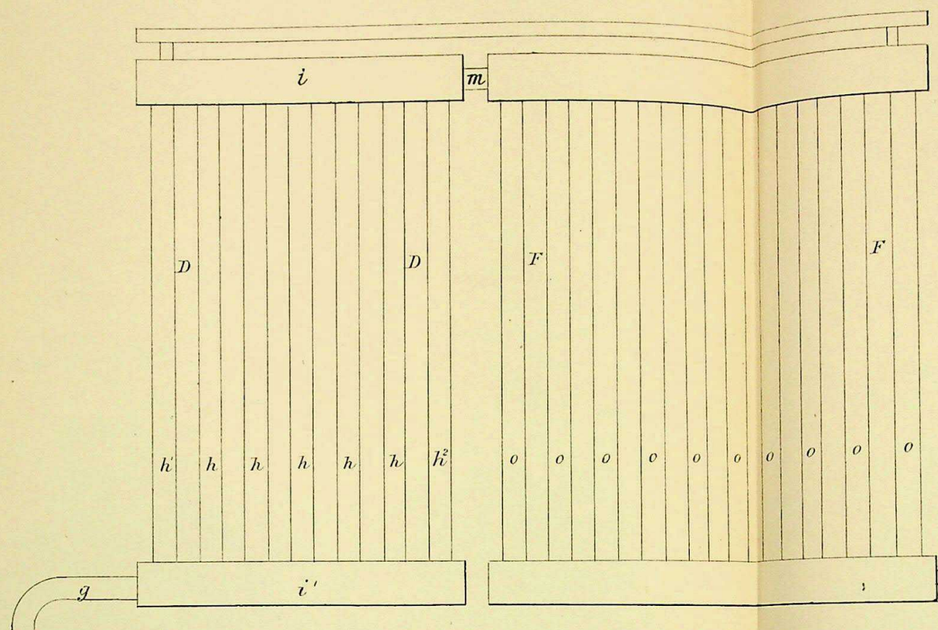
Printers to the Queen's most Excellent Majesty. 1867.



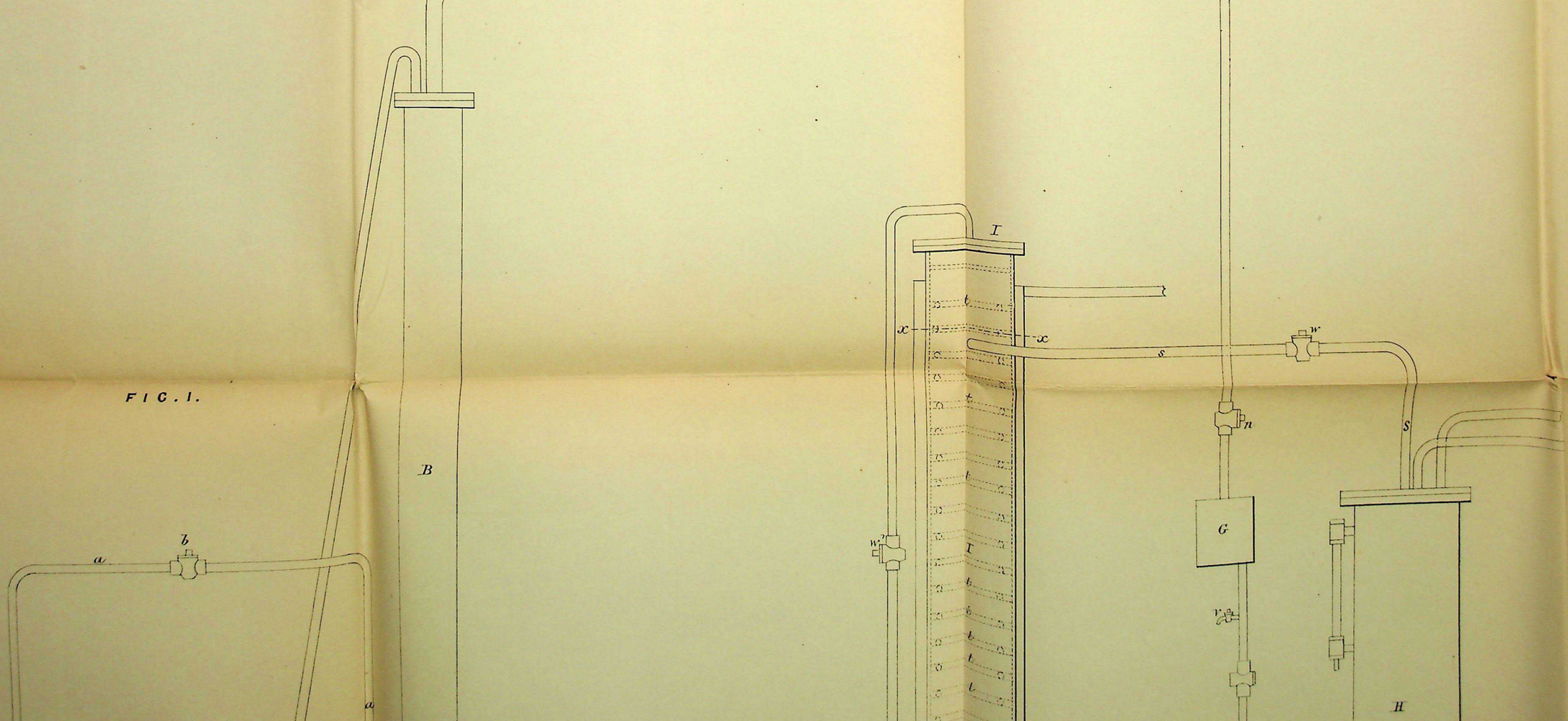
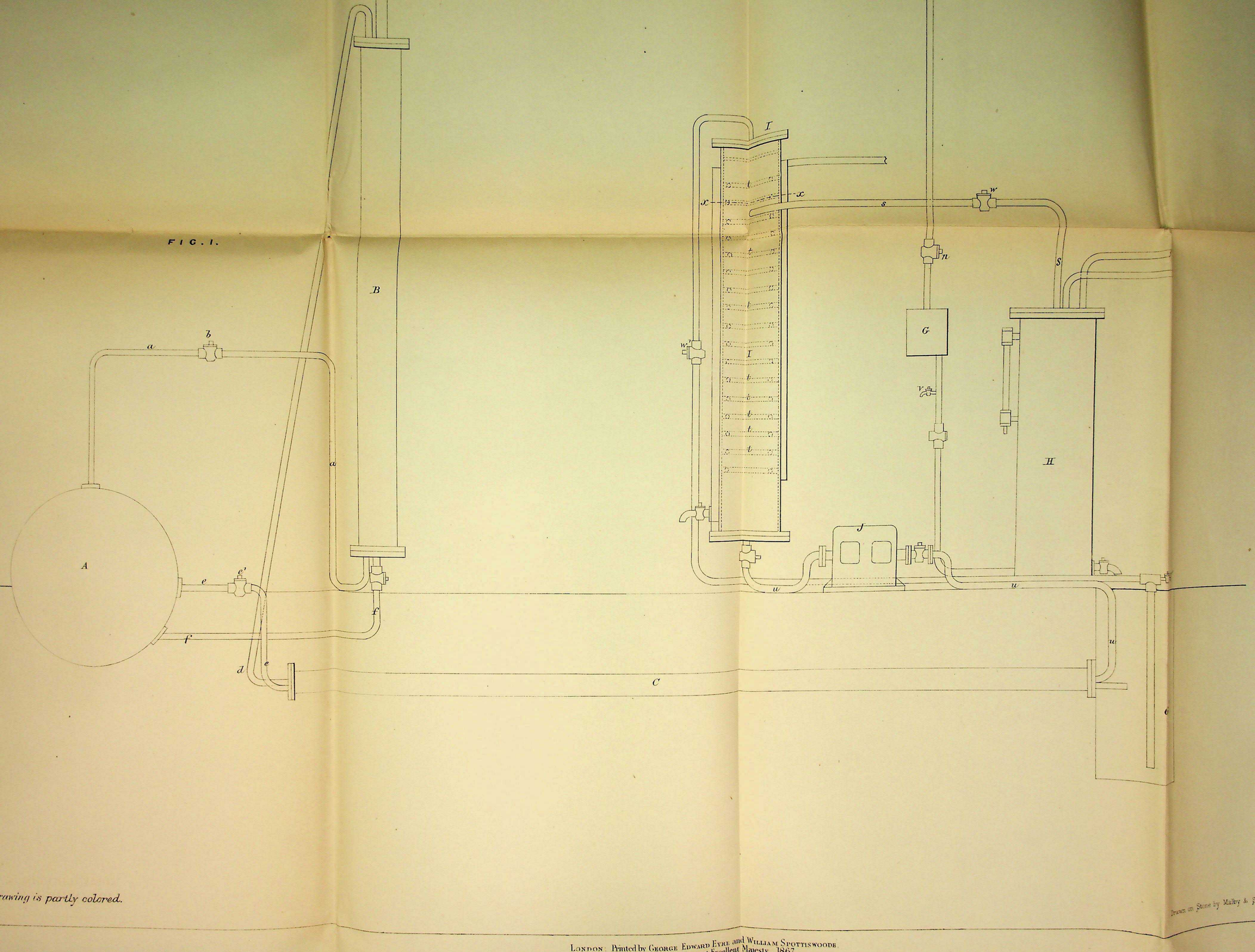


FIG. 1.

FIG. 1.



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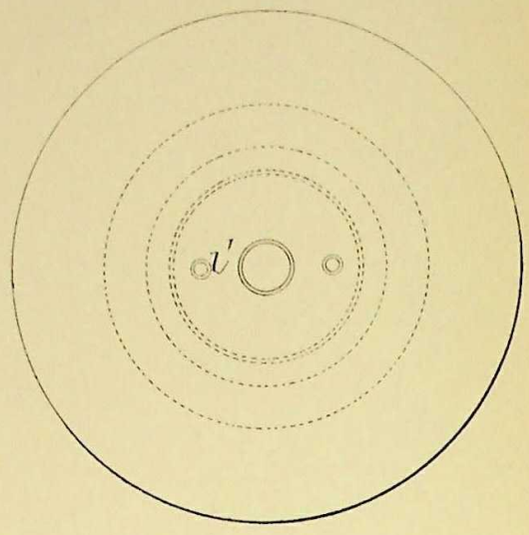
REECE'S Specification.

FIG. 6.



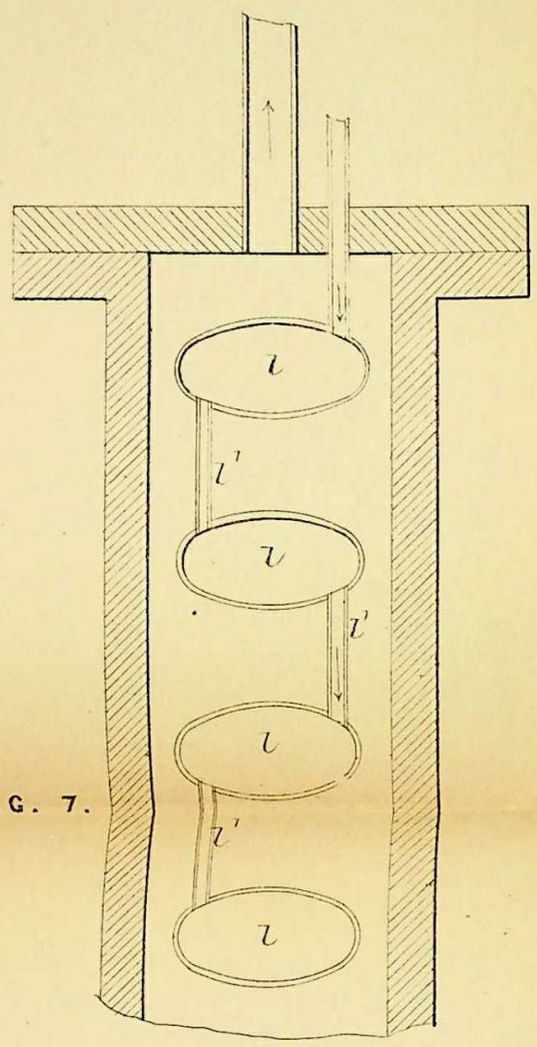


FIG. 7.

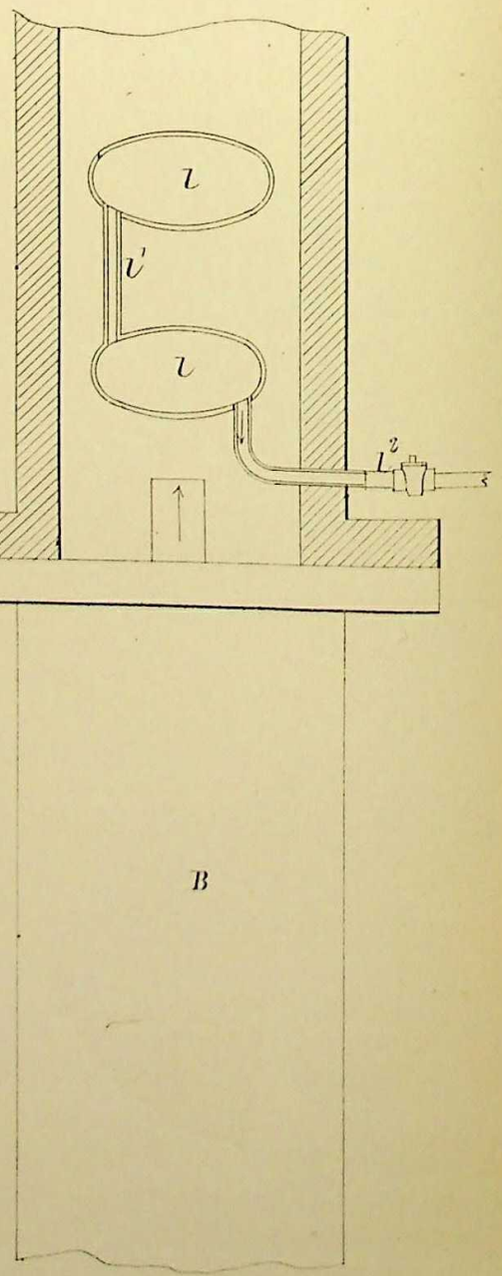
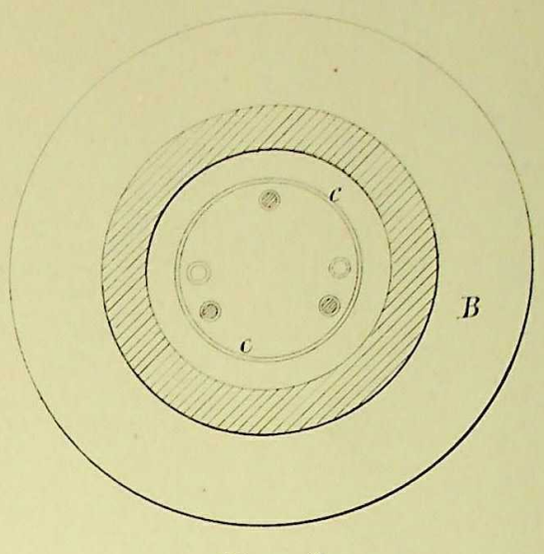


FIG. 2.



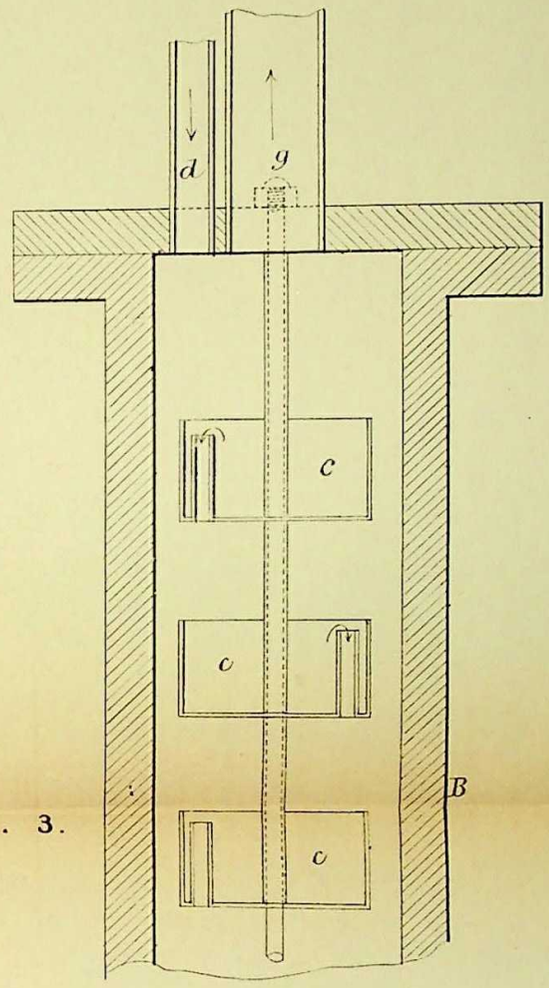
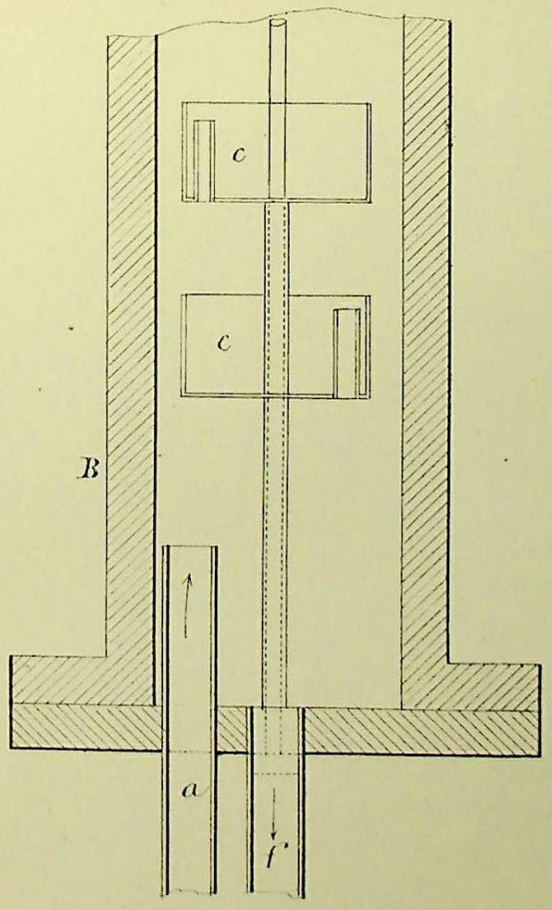


FIG. 3.



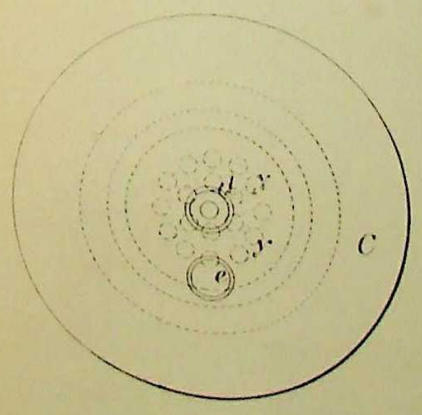


FIG. 12.

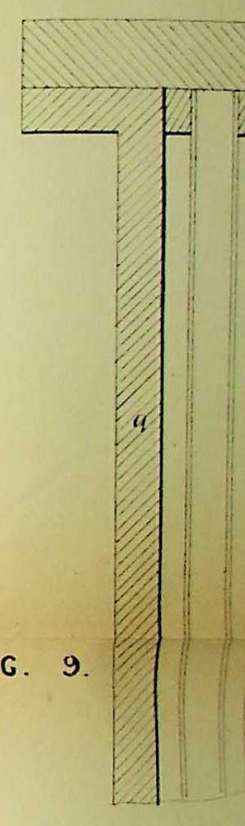
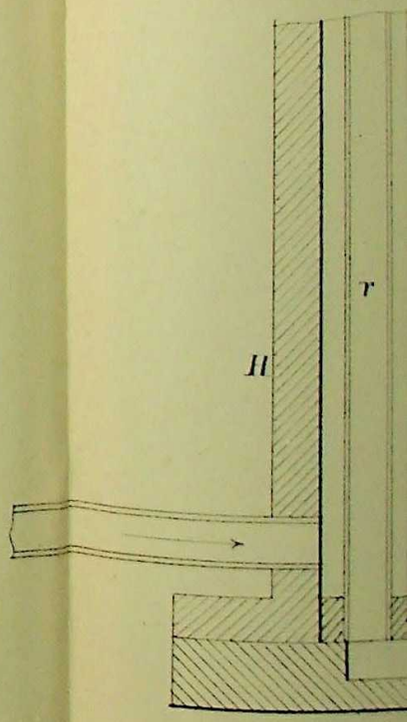


FIG. 9.



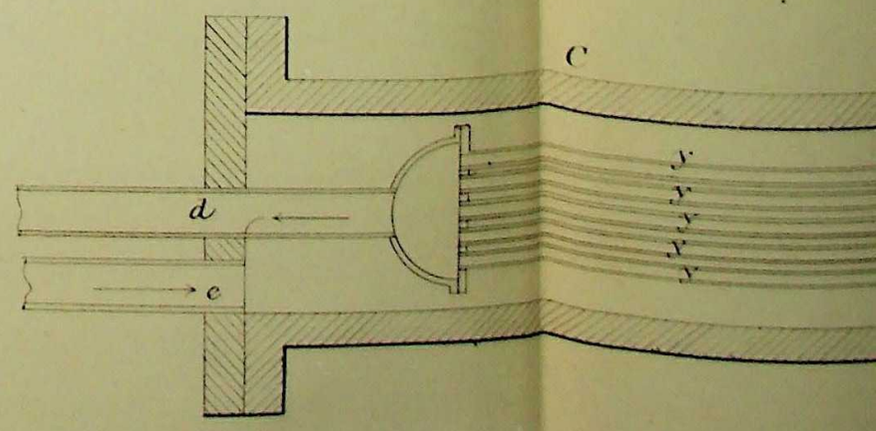


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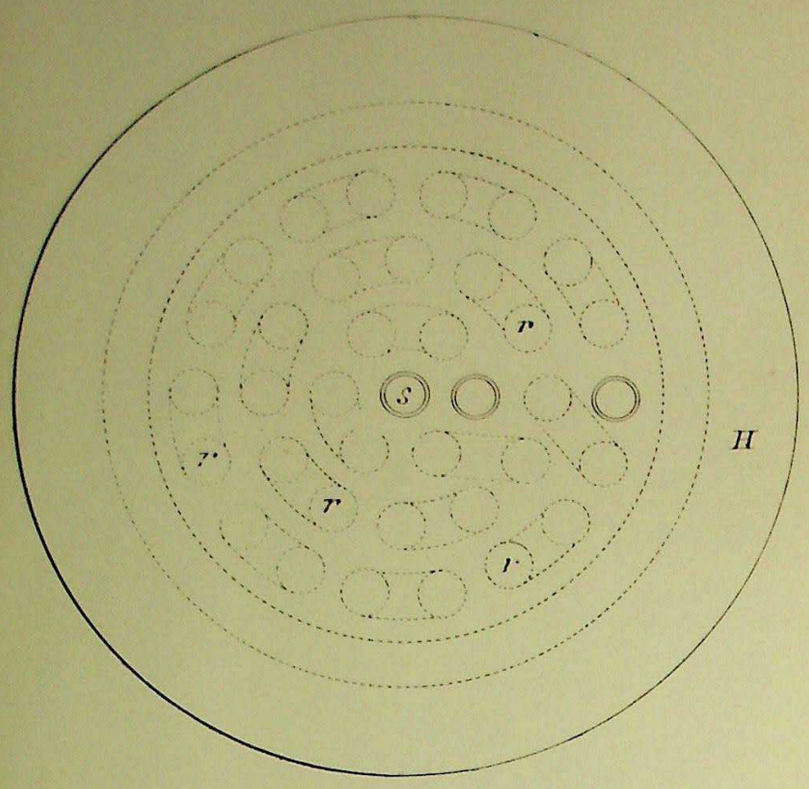
FIG. 8.



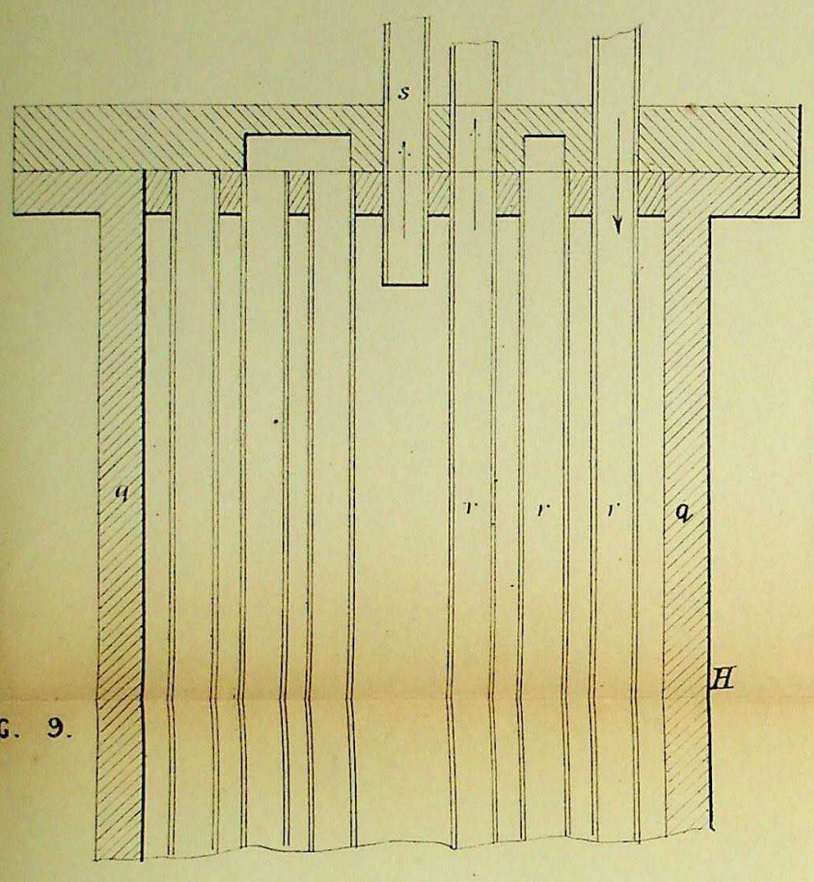
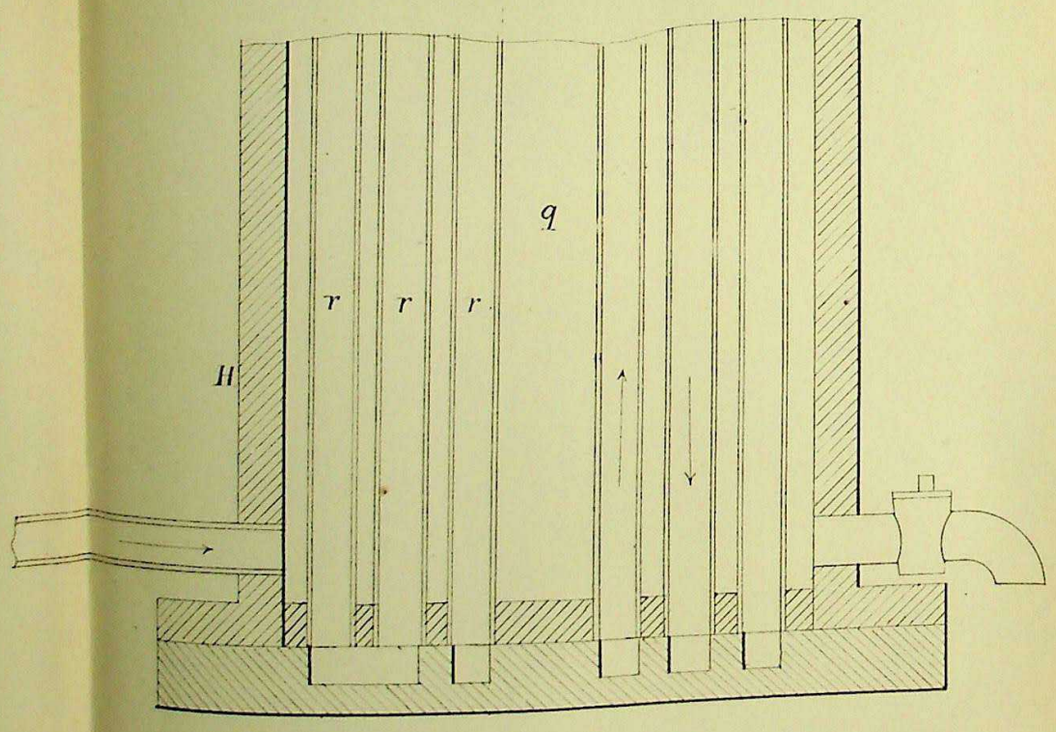
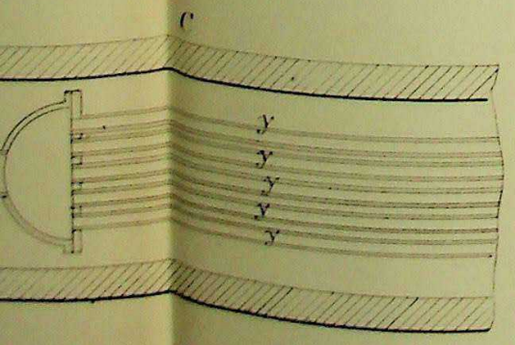


FIG. 9.





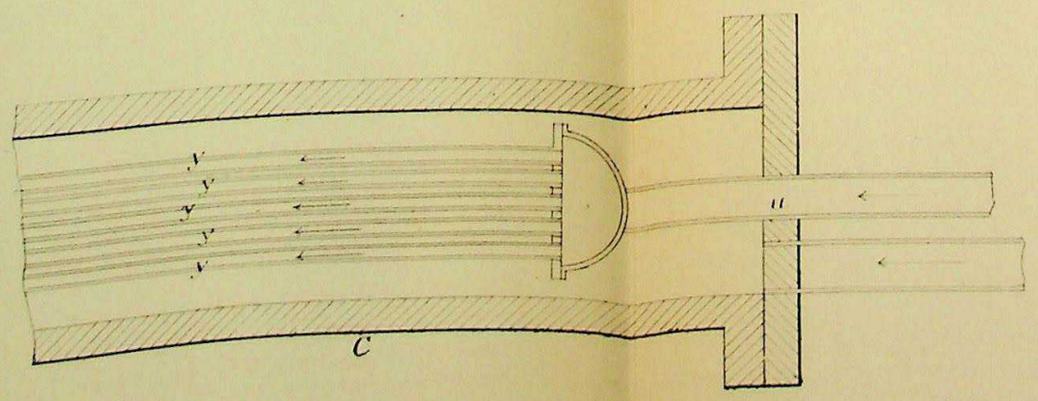


FIG. 11.

FIG. 10.

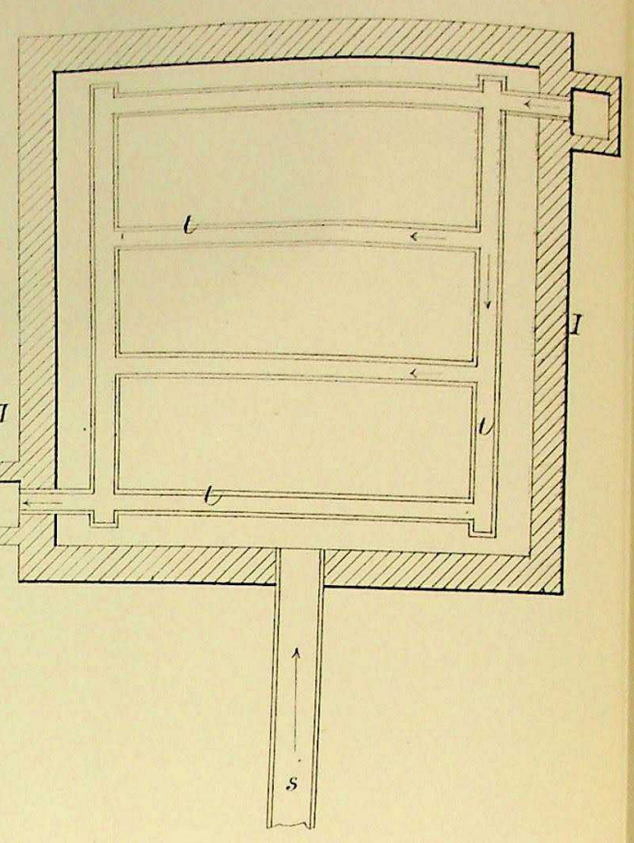


FIG. 4.

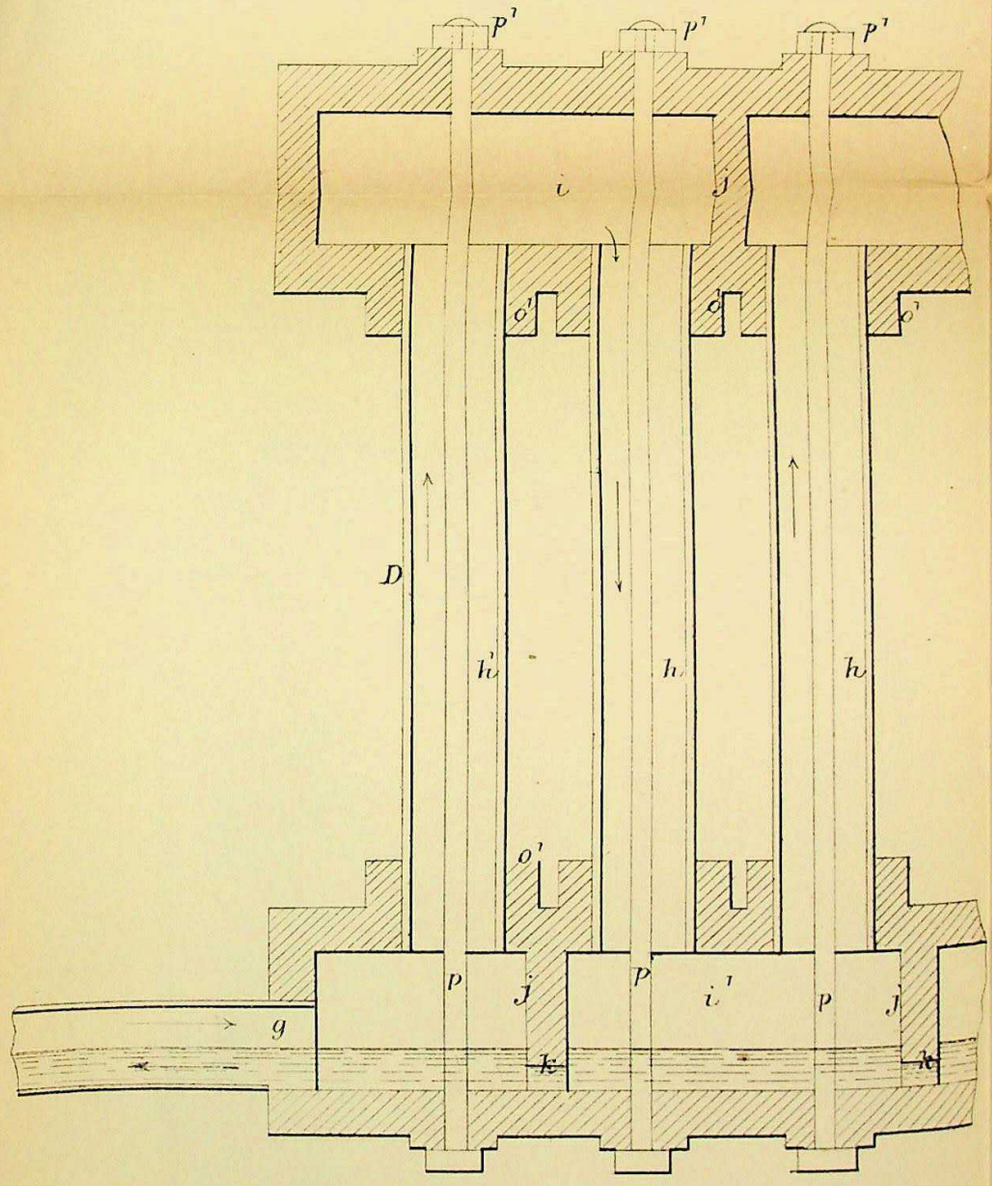
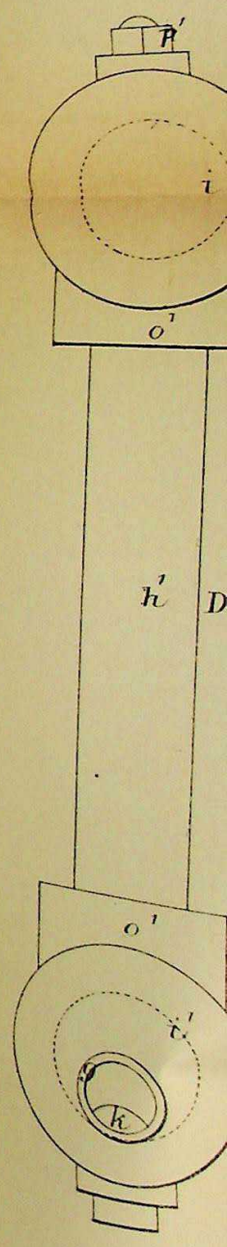


FIG. 5.



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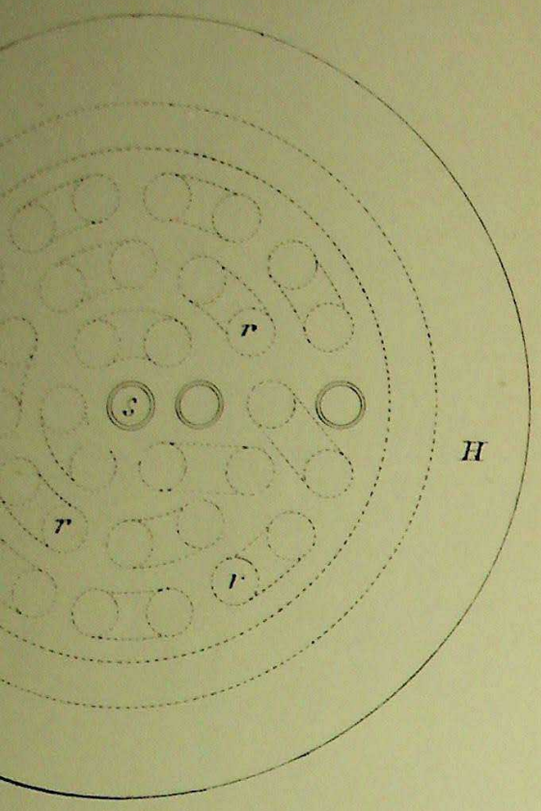
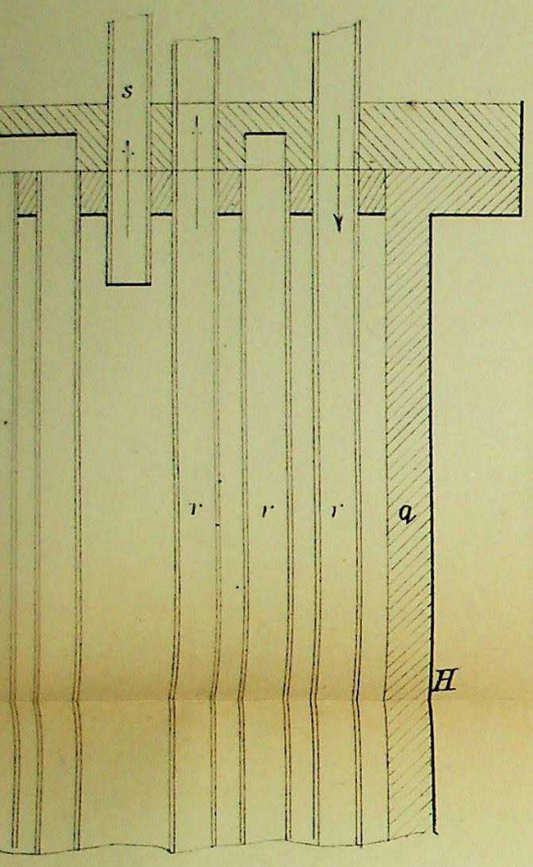
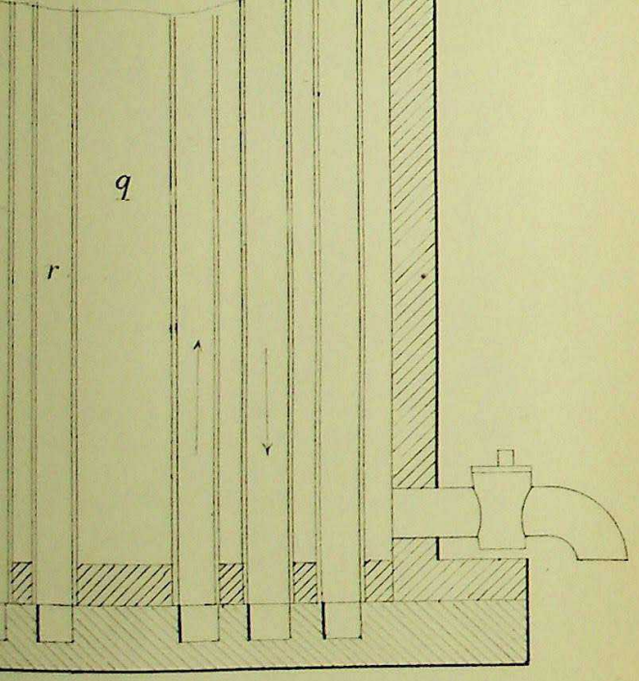
Printers to the Queen's most Excellent Majesty 1867

FIG. 8.







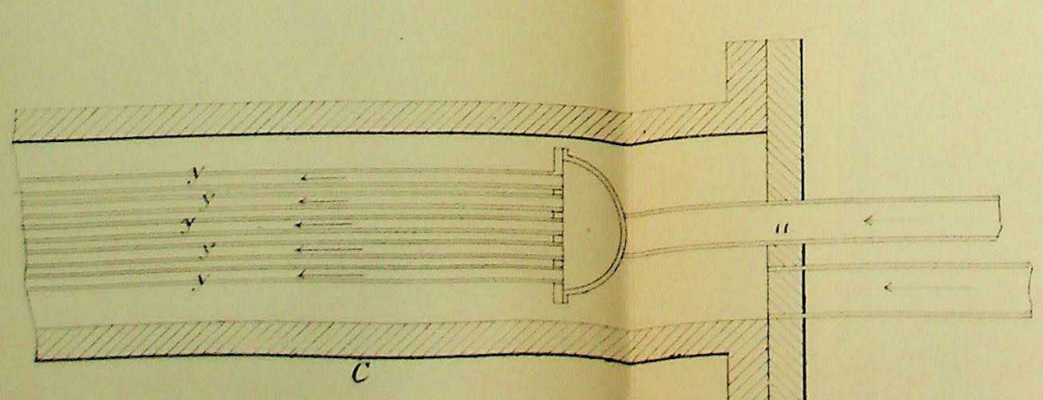


FIG. 11.

FIG. 10.

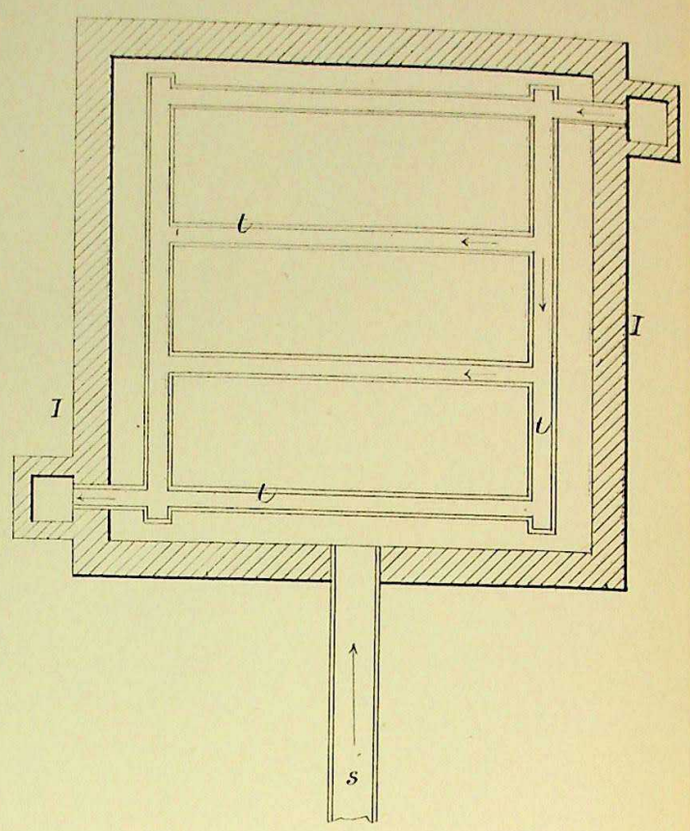


FIG. 4.

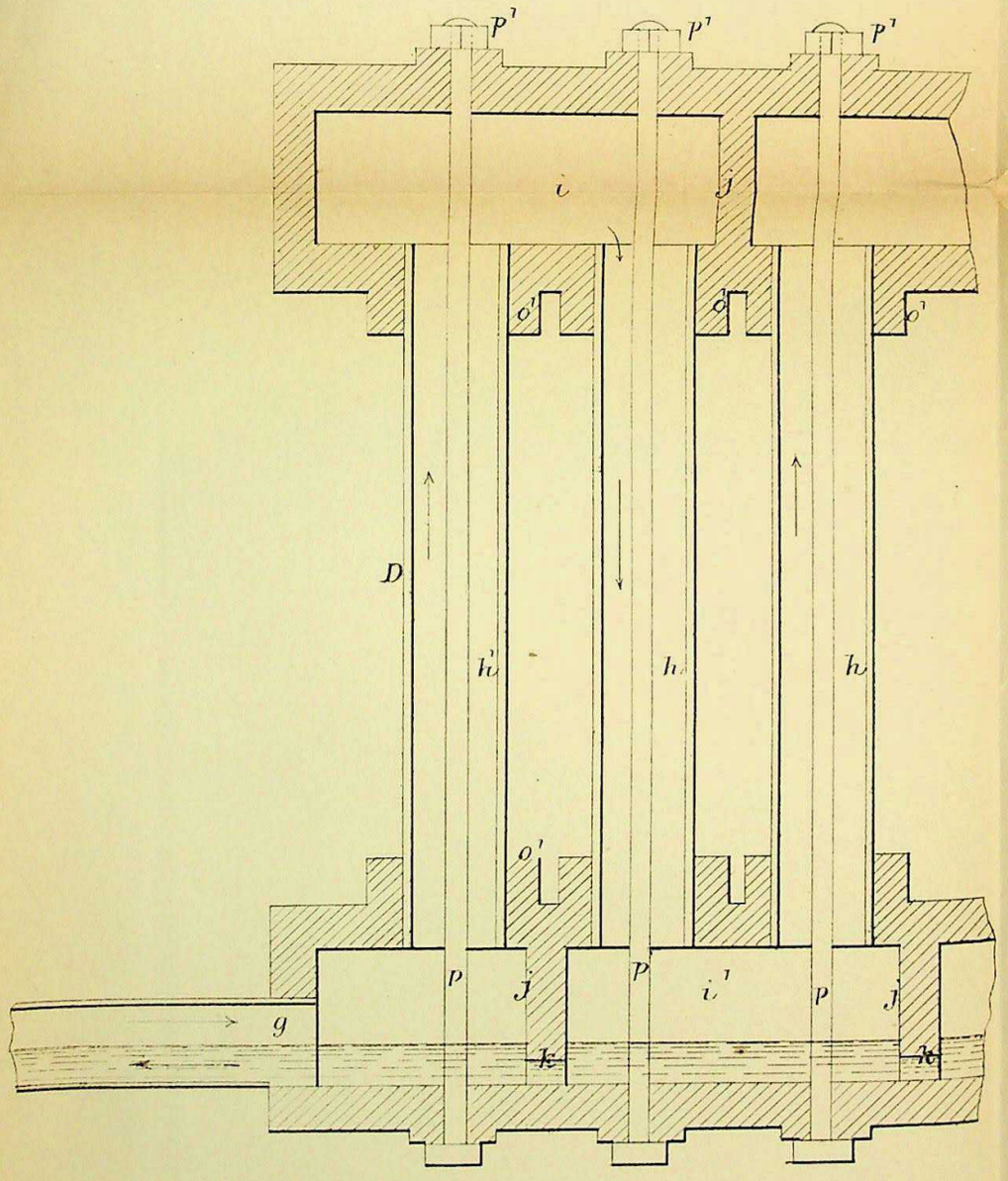
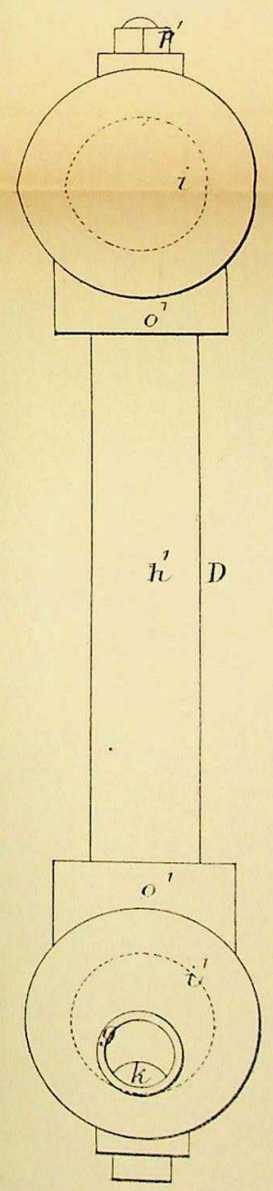


FIG. 5.



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Her Most Excellent Majesty 1867